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**NAVAL
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MONTEREY, CALIFORNIA

THESIS

**FORECASTING RETENTION IN THE UNITED STATES
MARINE CORPS RESERVE**

by

Joseph F. Schumacher

March 2005

Thesis Advisor:
Second Reader:

Samuel E. Buttrey
Robert McNab

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**FORECASTING RETENTION IN THE UNITED STATES MARINE CORPS
RESERVE**

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Captain, United States Marine Corps
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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

**NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

This is an empirical study using a logistic regression model to assess the impact of mobilization and unemployment on an individual's decision to stay in or leave the U. S. Marine Corps Reserves. The goal was to predict the attrition behavior of USMCR participants in order to better establish recruiting and retention goals in the Reserve population. Questions regarding attrition influencers, effects of mobilization, and applicability to both officer and enlisted personnel were reviewed in this process.

The effects of being called to active service are shown to have a positive effect on retention in the reserves. Similarly, serving in the SMCR and Stand-by Reserves are both shown in the model to have a positive effect on reserve retention. This makes sense, in that when an individual volunteers in the Marine Reserves, he or she evidences a desire to serve his country when called to do so. The negative effect of an increase in the number of days served on active duty, as shown in the results of the model, follows similar logic. Had the individual wanted to serve on a full-time active duty basis he would have volunteered for the active duty component. The longer he is asked to remain on active duty, the more dissatisfied he is, on average, with his participation in the reserves.

The negative effect of an increase in the individual's home of record unemployment rate is also consistent with previous findings, and when combined with the negative effect of continued mobilization and recall from the IRR or retired status, a significant negative impact is seen on the individual's decision to stay in. The findings indicate that multiple short activations have a positive

impact, whereas the impact of fewer, lengthy activations is negative. This study validated previous research regarding the likelihood to continue to serve in the Marine Corps Reserves. As a result, the Marine Corps has the potential to better allocate resources and schedule individual activations, reducing attrition. This can assist in developing the proper force structure when the services of the Marine Corps are needed.

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I. INTRODUCTION

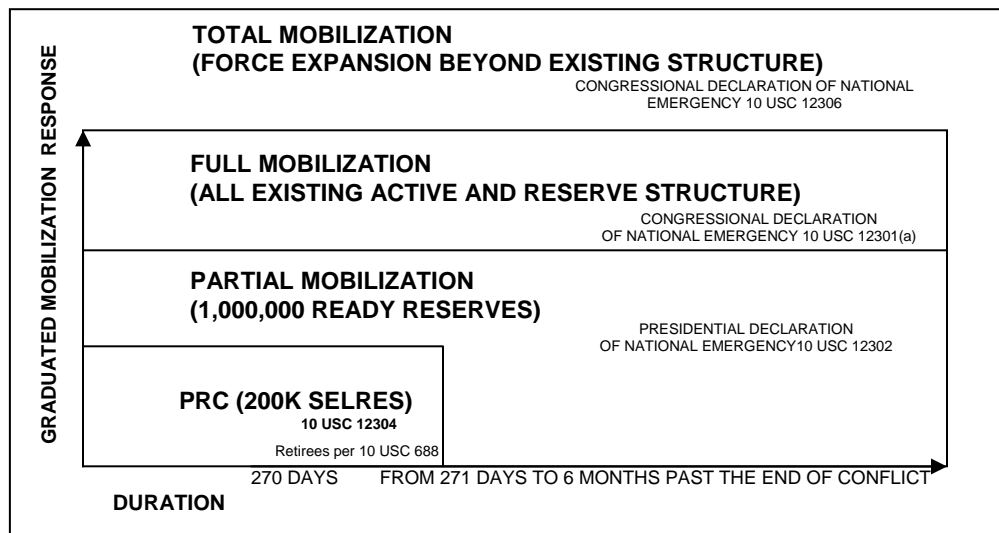
A. PURPOSE

Currently Marine Corps Reservists are being called upon to fulfill requirements that would have been assigned to the active duty component only 15 years ago. [Ref 1] During peacetime, Headquarters Marine Corps Reserve Affairs planning has established a sustainable mix of the active and reserve components, particularly in determining active and reserve requirements when given sufficient lead time to enable the plan to be implemented effectively. Though many would expect the Marine Corps to maintain the same force structure during peace as it does during war, this is not the case. Wartime requirements have consistently obliged the Marine Corps to increase manning levels. Predicting individual Marine responses to wartime activation levels is the aim of this analysis. This thesis is a continuation of the research of Captain J. Klingerman titled "Predicting Attrition of United States Marine Corps Officers by Rank and Military Occupational Specialty." [Ref 2]

B. BACKGROUND

Recently the United States Marine Corps Reserve (USMCR) has been called into action to support major operations such as Operation Desert Shield/Storm and the Global War on Terror. In 1973, the Total Force Concept transitioned the armed services from a conscript force to a volunteer force. However, the change in reserve force utilization did not begin until Operations Desert Shield and Desert Storm in 1990-91. [Ref 1] This is significant because the interpretation of the Total Force Concept was

different prior to that time. From 1973 to 1990 the reserve force was a "just in case" force that would augment individuals or train small units to fill larger units that were below operational levels. In the six-month period leading to the first Gulf War entire units were deployed to work as mirror images of the active force. Additionally, the several specialties that were found solely in the Reserve Force structure, such as Air Naval Gunfire Liaisons and Civil Affairs personnel, were totally activated. At the end of the conflict there was a quick draw-down in the force utilization of the USMCR, but it did not drop to the pre-war level of mobilization [Ref 3]. Operations in Haiti, the horn of Africa, the Philippines and Bosnia were supported by USMCR forces necessitated increased mobilization rates. As the current War on Terror continues, the reserve forces have increased their mobilization level.



(Adapted from: 2004 USMC M&RA Training Brief, slide 97.)

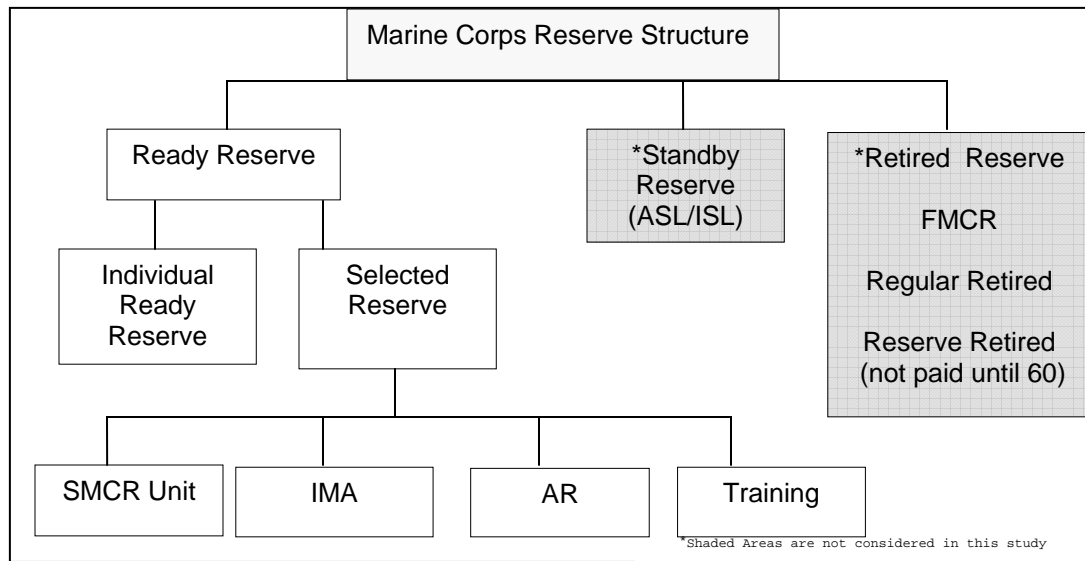
Figure 1. Mobilization and Availability of Reserves

The president authorized the partial mobilization of the reserve forces by his declaration of War on Terror on

the 12th of September, 2001. As shown in Figure 1, the USMCR will be available for this increased rate of mobilization until the War on Terror is over as defined by U.S. Public Law No:107-56 (Patriot Act).

C. RESERVE FORCE STRUCTURE

The USMCR is designed to act as a fourth Marine Expeditionary Force (MEF); to that end it includes an infantry division, an air wing, and a force service support group. There are also seven regional Reserve Support Units that facilitate annual training and mobilization. The USMCR has, in addition, a headquarters unit based in New Orleans, Louisiana. These major commands are broken down into lower-level commands. The sub-units are split into company- or detachment-size units and are located throughout the United States and Puerto Rico. This allows members serving in the reserves to have a localized command to which they report. Marines can serve in the reserves as obligors, those having a signed commitment for a specific period of service, or as non-obligors who serve at their own discretion. All Marines that serve in the reserves are one of these types: Ready Reserves, Standby Reserves, and Retired Reserves (Figure 2).



(Source: Author)

Figure 2. Marine Corps Reserve Force Structure

1. Ready Reserve

These Marines are subject to recall for active duty in the time of war or national emergency, or when otherwise authorized by law. The Ready Reserve is broken down into the Selected Marine Corps Reserve (SMCR) and the Individual Ready Reserve (IRR).

a. Selected Marine Corps Reserve

The SMCR consists of three elements: SMCR units, Individual Mobilization Augmentees (IMA) and the Active Reserve. These elements work regularly with the Active component Marine Corps, and are often integrated with active forces.

b. Individual Ready Reserve (IRR)

The IRR consists of all Marines in the Ready Reserve who have yet to complete their Initial Mandatory Service Obligation (IMSO), or have completed their IMSO and are in the Ready Reserve by voluntary agreement.

2. Retired Reserve

The Retired Reserve consists:

a. Fleet Marine Corps Reserve (FMCR)

The Fleet Marine Corps Reserve is made of enlisted personnel retired after 20, but fewer than 30 years of active service and who are receiving retirement (retainer) pay. After 30 years of service, members of the FMCR are transferred to a retired list.

b. Retired Reserve Awaiting Pay

This category is made of eligible Reserve Marines who have completed at least 20 years of service, and have requested a transfer to the Retired Reserve with pay. Retirement pay for these individuals begins, if applied for, at age 60.

c. Retired Reserve in Receipt of Pay

This category consists of Reserve Marines with at least 20 years of qualifying service who at age 60 applied for and are receiving retirement pay. Members are placed on the Retired List of the Marine Corps Reserve.

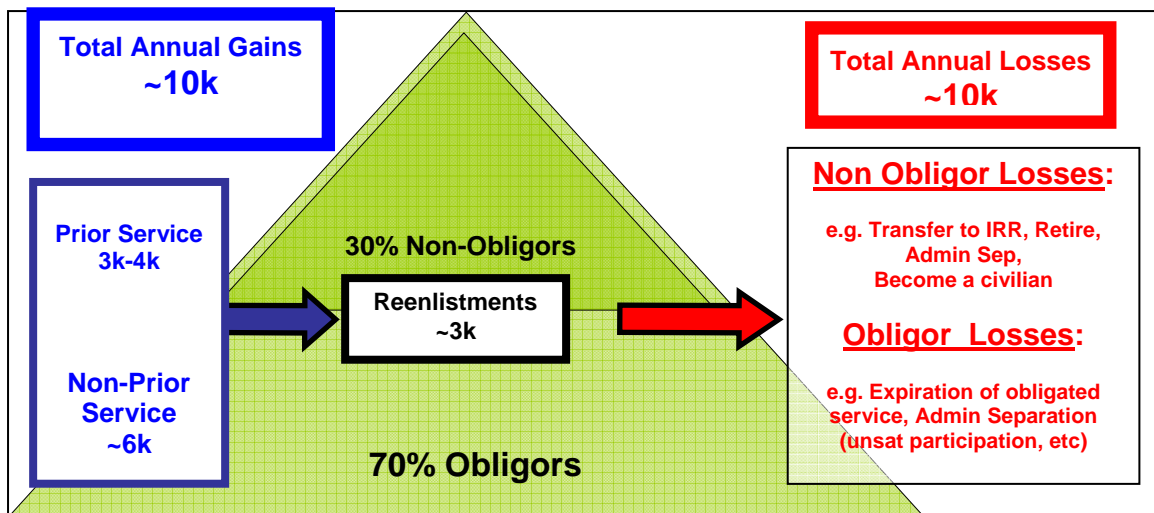
3. Standby Reserve

The Standby Reserve consists of Marines who are not in the Ready or Retired Reserve and who can be recalled to active duty in a time of war or national emergency.

D. METHODOLOGY

Both obligors and non-obligors in the Marine Corps Reserve are eligible to serve in the active forces. Because of the multiple modes of accession into the reserve force (direct entry, entry after completion of active service, re-entry after a period away from the service), each with its own contract length, the time from entry into the service is not a good distinguisher of obligor or non-obligor status (Figure 3). All non-retired reservists,

each of whom must make a “stay” or “go” decision regarding continuation of reserve service, are modeled in this analysis. The probability that an individual continues to serve in the reserves after mobilization, dependent in part on his or her individual and economic characteristics, is the subject of this analysis. I employ a logistic estimator to establish probabilities of retention by occupational fields by unit location. Bureau of Labor and Statistics unemployment data and Reserve Component Common Personnel Data System (RCCDPS) data are used in this analysis.



(Source: Author)

Figure 3. Selected Reserve Manpower Breakdown and Flow

E. OVERVIEW OF THESIS

Determining the probabilities of staying (continuing to honorably serve out an initial contract or deciding to reenlist for subsequent enlistments) in the reserves after mobilization, by occupational field, is the goal of this thesis. The mobilization data is from the Defense Manpower Data Center (DMDC) and is combined with state unemployment

rates to assess their effects on retention in a multivariate analysis.

Chapter II reviews previous studies in this particular area of interest to the armed forces. It establishes the rationale behind the variable and methodological approaches used in this analysis. Chapter III specifies the models and describes the data and variables used. Chapter IV provides the results of the analysis and presents an interpretation and application of those results. It also reviews the limitations of the study. Chapter V presents conclusions arrived at through the analysis and provides recommendations for further study in this area.

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II. LITERATURE REVIEW

Since the inception of the modern all-volunteer force of the United States in 1973, maintaining a sufficient number of well-trained personnel has been the focus of countless studies and analyses. Although they may seem synonymous, attrition and retention are separate and distinct areas of concentration that address this requirement.

A. BACKGROUND

Recruiting is the initial accession process of persons into the military. Though it involves many of the same issues as attrition and retention, it is outside the scope of this analysis. As previously mentioned, the key distinction in the Marine Reserve population studied is that of obligors versus non-obligors. The reason this is the dividing line is that the obligors are still subject to the contractual agreement assumed at the time of initial accession while non-obligors have no such commitment and are thus free to disassociate themselves from the organization much more easily.

This literature review is in no way all-encompassing. The volumes of research devoted to the topics of attrition and retention exceed the capacity of the author of this analysis. As a result, selections from particularly pertinent studies are reviewed to establish a valid theoretical framework for the methodology and direction of this paper.

B. ATTRITION STUDIES

The area of attrition investigates the factors that cause an individual to leave the service. Past works have identified many significant factors in this decision process. The following studies outline the characteristics and actions that have been identified as significant in this decision:

Klingerman (1970) [Ref 2] found that rank, specialty, educational attainment, and regional background were significant factors in the attrition equation. Though limited by lack of computer processing power, he was able to establish predictions of losses by specialty among Marine Corps colonels using a logistic regression analysis.

Packard (1976) [Ref 3] studied premature attrition, or attrition among persons not completing their initially contracted obligation within the Marine Corps. He found that geographic location of the individual's home of record and level of education were of significance in determining success rates. He attributed this to a propensity of human nature to return to the familiar, which is justified by his findings. He also found that age at enlistment, race and parents' marital status were of some predictive validity. The conclusion of his work was that positive leadership influence by the command is key in solving the problem of premature attrition.

Millard (1977) [Ref 4] performed a review of previously conducted attrition models. His findings, though not employed by the services, were that high-school graduates and non-graduates did not require separate attrition models. Current Marine Corps manpower models use separate explanatory models to explain attrition in these two groups. Millard finds that models would not gain

substantial accuracy or reliability by separating the subjects along this line, and concludes the populations may therefore be aggregated.

D'Amalio and Sevon (1978) [Ref 5] created an automated data system that produced historical files with background information on every Marine. They applied their system to the attrition problem and produced average monthly attrition rates by pay-grade, specialty, and location. They concluded that this system could address a multitude of similar prediction models with the database they had created. Currently this capability is housed in the Marine Corps Total Force System (MCTFS), which is connected to the RCCDPDS database used in the analysis conducted in this paper.

Lockman (1982) [Ref 6] took a slightly different approach to the issue of attrition. He found that the lag in pay differential between military personnel and similarly trained civilians was the cause of increased attrition in the late 1970's. He did distinguish between the effects of non-monetary policy changes and pay adjustments. His work found that the non-monetary changes were more significant in controlling pre-end-of-obligation attrition, whereas monetary considerations were of more importance in the decision to remain in the service at the completion of an obligation period.

Hurst and Manion (1985) [Ref 7] used a binary choice model to forecast attrition. They found that pay, unemployment rates, and promotion potential were significant in their equation. They also created a variable for "employability." They did this to quantify the applicability of an individual's education and skill in particularly profitable civilian employment markets.

Royle (1985) [Ref 8] studied the particular area of female attrition. She found that, across the various causes of attrition, supervisor relationship, family and career orientation, and stress management were significant indicators of attrition. She suggested that the Marine Corps should discourage women with traditionally female role expectations from enlisting in order to reduce attrition.

Hosek and Peterson (1987) [Ref 9] examined the apparent attitude reversal of persons who initially volunteered for service and then later decide to leave prior to the end of their obligation. They determined that the length of time spent in the Delayed-Entry Program (DEP) was significant in predicting attrition; the longer the successful time in the DEP the more likely individuals were to complete their initial obligation. They equated this finding to the commitment strength of the individual. They did not find a correlation between the initial enlistment decision and the outcome of the subsequent reenlistment decision. They suggest that the initial and follow-on attitudes are unrelated because of the significant impact of the individual's actual military experience. This concept is of particular interest in the present analysis. In studying the impact of mobilization on the "stay" or "go" decision initial enlistment decisions do not need to be considered because they are apparently not related to one another.

Buddin (1988) [Ref 10] looked at the attrition of high-quality recruits as compared with other recruits. He defined high-quality recruits as those with high-school diplomas. His findings indicate results similar to those of Millard in that individual characteristics are not

sufficient to adequately predict attrition. He found that command attrition policy played a significant role in attrition rates with good command support helping to decrease attrition. His findings were based on the large variance of similar cohorts at different commands.

Vernez and Zellman (1987) [Ref 11] found that family status of the service-member played a significant role in the attrition equation. They found that personnel in their first term of service who have families were more likely to separate, whereas service-members in a similar family situation but in subsequent terms of service were more likely to remain in the service. They also found that relocation and long separations from family both make continuation in the service less likely. This is particularly important to the Marine Corps because it has the highest deployment rate and longest separation periods of all the services. The researchers also found that lump-sum bonuses and duty station preference had much more measurable effects on retention than other quality of life programs. Their findings are similar to those in the majority of retention studies.

C. RETENTION STUDIES

While attrition studies focus on reasons for leaving, retention studies concentrate on how to keep persons in the service. Some of the dissimilarities between these two goals are identified in the following studies:

Quester (1990) [Ref 12] looked at the difference between male and female retention in the Marine Corps. She found that after 60 and 114 months female retention was increasingly greater than that of males with similar characteristics. As a result there is a higher proportion

of women in the senior leadership than in lower ranks, among Marine Corps specialties that allow women.

Hosek and Totten (1998) [Ref 13] specifically looked at the effects of long or hostile deployments on reenlistment decisions. They found that first-term reenlistments increased after Operation Desert Shield/Storm in the early 1990's (Figure 4). "Total Rates" in Figure 4 refers to the by-service reenlistment rate by specialty field. They did find that "too much" exposure to such deployments did decrease retention. As a result, they suggest that finding the appropriate balance in deployment time is of significant importance to personnel planners.

Total Rates by Occupation Before and After the Gulf War (percentages)								
Occupation	Army		Air Force		Navy		Marines	
	Prewar	Post-war	Prewar	Post-war	Prewar	Post-war	Prewar	Post-war
Infantry, gun crews, and seamanship	6.2	9.2	2.4	9.1	13.6	16.2	19.8	25.2
Electronic equipment repairers	6.8	10.0	2.1	5.9	9.6	13.0	10.5	13.3
Communications and intelligence	6.6	9.4	2.9	5.9	11.2	14.0	14.5	17.4
Medical and dental specialists	4.0	7.1	1.3	3.0	4.7	5.8	NA	NA
Other technical and allied specialists	5.7	7.8	2.9	6.0	7.3	9.2	8.1	10.1
Functional support and administration	5.0	7.8	2.3	5.4	9.1	11.9	9.1	11.6
Electrical/mechanical equipment repairers	7.1	11.0	2.0	7.3	11.9	14.2	12.9	16.6
Craftsmen	6.8	9.5	2.9	6.8	14.2	16.3	13.6	17.2
Service and supply handlers	6.3	9.8	2.8	7.1	12.7	15.3	14.6	16.4
Service total	6.1	9.1	2.3	6.3	10.9	13.4	14.3	17.8
NOTE: Personnel in DoD occupation code 9 are excluded (i.e., trainees and personnel who are hospitalized or in military prison).								

(from Hosek and Totten, Table 3.1)

Figure 4. Reenlistment Rates Before and After the Gulf War

Kocher and Thomas (2000) [Ref 14] and Hocevar (2000) [Ref 15] created and evaluated a retention survey for the Marine Corps. They used factor analysis and constructed

variables that measured the "stay" or "leave" decision. They found that pay and civilian opportunities were significant predictors for all personnel. They also found that gender and length of service had significant effects, but that the level of effect varied between officers and enlisted personnel.

Fricker (2002) [Ref 16] continued the research of Hosek and Totten with post-Desert Shield/Storm data. He found that no matter the type of deployment, whether hostile or non-hostile, retention was increased. He admits that he was unable to determine how far this relationship continued in terms of deployment length or periodicity. His conclusion is that some of these persons seem to have joined the military specifically to deploy and participate in combat.

Kirby and Naftel (1998) [Ref 17] looked specifically at reservist retention and its relationship to mobilization after Operation Desert Shield/Storm. Their findings were similar to those of Fricker and Hosek and Totten with the exception that multiple deployments were related to lower retention. The other studies only hypothesized this relationship. Kirby and Naftel also found pay-grade, race, and spouse attitude were important individual characteristics in predicting retention probabilities.

Hairston (2004) [Ref 18] looked at a subset of the Marine Corps population. His focus was specifically on non-obligors who had reached the rank of Staff Non-commissioned Officer. Marital and dependency status, rank, and specialty were found to be significant influences for persons in this population regarding their continuation decisions.

This thesis is framed within the findings of the research of this literature review. It is understood that while this is not an all-inclusive review, it does represent the majority of the findings within this area of research over the past 35 years. The characteristics and variables that have been identified as significant will be utilized in this analysis insofar as the available data supports its inclusion.

III. DATA AND METHODOLOGY

A. INTRODUCTION

This chapter reviews the data used in the statistical analyses, provides descriptions of the dependent and explanatory variables used in the models, and presents basic descriptive statistics of the data. The analysis is used to identify significant information about mobilization and its influence on retention through the use of logistic regression.

B. DATA

The Defense Manpower Data Center (DMDC) and Bureau of Labor Statistics (BLS) provided the data used in this study. The files were extracted from the Reserve Common Component File in the case of the DMDC data. The master files for this information is maintained at Fort Ord, California. The BLS data was extracted from the BLS website which provides database search capability.

The Reserve Component Common Personnel Data System (RCCPDS) is an electronic database maintained by DMDC-West. RCCPDS serves as the long-term storage facility for all Marine Corps Reserve data file. The Marine Corps prepares and submits a monthly master file that shows the status of each member of the reserve component as of the last day of each month. Additionally, transaction data showing the changes of reserve component personnel files are submitted on a weekly basis to DMDC and include all authorized transactions as of the date of submission. The result is a snapshot view of the entire reserve force as of the date of submission to DMDC.

A request for data that contained all Marine Corps reservists for the period from 1988 to present was submitted to DMDC. The following electronic personnel files were provided by DMDC: October 1988, quarterly from October 1989 to December 1990, one for each month from January 1991 to December 1992, and monthly from period October 1996 to July 2004. The first data series begins in October as a result of the fiscal year start date of 1 October for the Marine Corps. The reason there is an inconsistent period length in the data is that there is a reporting period change in frequency from quarterly to monthly data cycles. The data gap from 1992 to 1996 is a result of data storage and transfer quantity limitations.

The data sample includes the variable types for the period from October 1988 thru December 1992, shown in Appendix 1, and a separate set of variables for the period from October 1996 thru July 2004 as shown in Appendix 2. These variables were chosen based on criteria established as relevant to the decision to "stay or leave" the Marine Corps Reserve by previous retention and attrition studies. Unfortunately, many of the values expected in these variables were missing as a result of poor data entry.¹

Additionally, the research was limited to the information available from the BLS and DMDC. There are other variables, such as individual satisfaction with the Marine Corps experience, that contribute to the "stay or leave" decision that are not held in these databases.

¹ Diary clerks are responsible for the input of all personal information fields for Marine Corps personnel in their respective units. The accuracy and consistency of this data entry is limited to the ability of the clerk to obtain and then transfer the correct information into the RCCDPDS system. As a result, there are some variables that are affected by the inaccurate or missing data.

C. THEORETICAL FRAMEWORK

The theory behind this analysis is that there is an explainable relationship between the number and length of activation periods and a Marines staying in or departing from the Marine Corps. To that end, the following methods were employed.

1. Logistic Regression

The value of the dependent variable is interpreted as the probability of an individual continuing to serve as a member of the reserves up to a specific level of activation as shown in the following equation:

Hypothetical Model

$$P(\text{continue to affiliate}) = 1 / (1 + e^{-(B_0X_0 + \dots + B_KX_K)})$$

The value (P) is defined as the probability that a Marine continues to affiliate with the reserves and e is the base of the natural logarithm. The X's are the values of the explanatory variables, the B's are the values of the estimated parameters in the model, and K represents the number of explanatory variables analyzed for each individual.

Logistic regression is used because it is designed for binary dependent variables. Were a linear probability model used the model would be bounded. Logistic regression eliminates this particular problem. This is accomplished by using a variant of the cumulative logistic distribution.

2. Model Specification

The theoretical logistic regression model specification for the probability of continuing to affiliate with the reserves is shown here:

MODEL 1

Stay-in = $f(\text{Sex, Number of Dependents, Years in Service, Length of Time Mobilized, Number of Mobilizations, Months Served in a Reserve Category, and Yearly Home of Record State Unadjusted Unemployment Rate at the End of Service})$.

These variables were selected based on influential factors in the "stay or go" decision suggested in the literature review.

Because the goal of this analysis is to predict the behavior of an individual based on his or her amount of mobilization and specialty, variations of the hypothetical models are proffered below:

MODEL 2

Stay By Primary Military Occupational Specialty Field = $f(\text{Sex, Number of Dependents, Years in Service, Length of Time Mobilized, Number of Mobilizations, Months Served in a Reserve Category, and Yearly Home of Record State Unadjusted Unemployment Rate at the End of Service})$.

3. Hypothesized Effects of the Explanatory Variables

The independent variables for the 'Stay-in' and 'Stay-in by Primary Military Occupational Specialty Field (PMOS)' continuation models were chosen based on previous studies.

The following variables are hypothesized to increase continuation propensity among reservists: Sex (if female), Number of Dependents (if married), Time in Service (if above (8) years), Length of Time Mobilized (up to 180

days), Number of Mobilizations (up to 2), increases in Months Served in a Reserve Category, and increases in Yearly Home of Record State Unadjusted Unemployment Rate at the End of Service.

Variables hypothesized to have a negative effect are: Sex (if male), Number of Dependents (if unmarried), Length of Time Mobilized (if above 180 days), Number of Mobilizations (above 2), decreases in Home of Record State Unemployment Rate at the End of Service, and increases in Number of Changes in Reserve Service Categorization.

It is understood that there is the potential for some correlation between certain variables. These are the variables 'Number of Months in a Reserve Category' and 'Number of Mobilizations'. Because the goal of this analysis is to determine the overall probability of an individual to stay, these variables are left as independent influencers rather than attempting to calculate the partial effects of the influence for each variable.

4. Base Case

The base case to which each of the independent variables in **Model 1** are compared is a single male with no dependents, with no mobilizations, and zero years of service. In **Model 2**, which includes State and PMOS Field, the base case is the same as in Model 1.

D. SELECTION OF DEPENDENT VARIABLE

An individual Marine's decision to "stay or go" in the reserves is typically of the most interest at two times during a 20-year career. These are at the end of his initial obligation (typically 4, 6, or 8 years) and again at the end of his second enlistment. The Marine Corps categorizes careerists as anyone remaining in the service

beyond his or her initial obligation. These two times were determined to be critical decision points because if an individual serves beyond this point, he will typically remain to serve until retirement eligibility at 20 years of service for retirement benefits.

The nature of this study, to determine the impact of mobilization on the reserve forces, required the tracking of changes in the 'stay' decision over the length of the individual's entire career. Any departure from the initial enlistment decision was investigated to determine its connection to the independent variables. Because there are only two options, "stay or go," an individual is binarily coded as a one (1) if he remains in the service or as a zero (0) if he separated or accepts retirement. Hence, the classic separation of careerist and non-careerist is discarded in this study.

The dependent variable "Stay-in" for each of the models includes all persons still serving at the end of the observed period minus those who accepted retirement when eligible. It is understood that the effect of 'staying' could positively influence the results because of individuals that would leave the service after the data period ends but before reaching retirement eligibility. This positive effect is assumedly countered by the negative effect of those individuals who entered the dataset prior to the beginning of the observed period and exited within the observed period.

E. EXPLANATORY VARIABLES

1. Description

The explanatory variables used in this study are: Years in Service, Sex, Number of Dependents, Length of Time Mobilized, Number of Mobilizations, Months Served in a Reserve Category, and Yearly Home of Record State Unadjusted Unemployment Rate at the End of Service.

2. Variable Construction

The data used includes individual files for each month in the period from 1988-1992 and from 1996-2004. As a result an individual may appear on multiple files, categorized by Social Security Number (SSN), if his career covers more than one reporting cycle. These separate records are consolidated, with the pertinent information from the individual's entire record of observed service, into a single master file set. The criteria and justification for determining what data is pertinent from each individual's career record are defined below.

a. Missing Variable Data

Any appearance of (Z), (.), or (99***9) in a variable's data field is considered as missing data values as defined by the DMDC file definitions.

b. Record Periodicity and Pay-years

Appearances of individual records have been categorized into 24 distinct types (see Appendix 3). Types 7, 8, 11, and 12 are persons whose records cover the end of the first dataset and the beginning of the second dataset. The assumption is made that these individuals continued in service throughout the period of the break in the dataset.

As a result, values that require summations of total service time (e.g. Total months observed per individual) have the missing periods added to the length of the overall

period. For those records that begin or end in the gap in data, it is assumed that the effects of these two types of individuals cancel each other out. (e.g. Individual joins during the break roughly equals losses during the break.)

(1) Individuals with Broken Time. There are certain Types (13-24) that have records in both data sets, but are not present in the last data file of the first data set or they are not present in the first file of the second data set. The sum of these individuals make up 0.51% of the observed records. The small number of these individuals preclude their being of influence in the overall analysis. Rather than delete them from the study, they are included with the logic that there may be some particular events that triggered their decisions to stay or leave the Reserves.

(2) Individuals Who Retire. The final Types that require explanation are the individuals that have an observed end date with no observed begin date (entry was prior to the data set), or they have an observed entry date with no observed end date (end of service is beyond the end of the data set). Similar logic is applied to these individuals as those of types 7, 8, 11, and 12. It is assumed that the effects of these two groups of individuals will cancel each other out.

The total number of years that an individual has served in the reserves is reflected in the variable "Pay Years." This variable is calculated separately and is its own data field held by DMDC. As a result it is unaffected by the data gap and is not subject to the associated assumptions.

c. Reserve Category Groupings

The value of the variable Reserve Category Group is separated into four distinct groups rather than the six categories used by DMDC (Figure 4). Categories 1, 2, & 3 have the same designation within the Marine Corps Reserves system. As a result these DMDC defined categories are grouped into one category for this study and labeled 'RCGA'. Categories 4 'RCGB', 5 'RCGC', and 6 'RCGD' are separate and distinct values and are handled as such in the analysis.

Code	Definition
1	Selected Reserve (not including AGR or MILTECH)
2	Active/Guard Reserve (AGR)
3	Military Technicians (MILTECH)
4	Individual Ready Reserve (IRR) / Inactive National Guard (ING)
5	Standby Reserve (Active and Inactive)
6	Retired Reserve

(Source: Author)

Figure 5: Reserve Category Codes and Definitions

(1) Changes in Category. Of particular interest are the changes in category that occur throughout a career. These changes in category are summed and create a new variable labeled 'RCGCHG'. This variable indicates a change in assignment for the individual, whether activation or reassignment. As such, the number of these changes is tracked along with the total number of occurrences of each category type, 1, 4, 5, or 6. The missing data period of 1992 to 1996 is not included in this quantity because of the impossibility of correctly recreating these changes accurately during this unobserved period.

(2) Changing to the Retired Category. Reserve Category Group 6 is of particular interest because it indicates the retirement of the individual. These individuals are included as "goer's" as of the date of

entering retirement, and are added to the population of individuals who terminate service during the observed periods. The data on these individuals in Reserve Category Group 6 is taken from their last active reserve file (the first occurrence of a '6' in this field) and applied to the individuals' consolidated record of service.

d. First Occurrence of a Variable

Information from the first occurrence of a record is used for the variable 'Sex'. Individual response levels are shown in Figure 6.

	Value	Stay-in	Leave	Total
Sex	F	5766	15032	20798
	M	94336	322271	416607

(Source: Author)

Figure 6. Stay-in or Leave Response by Sex

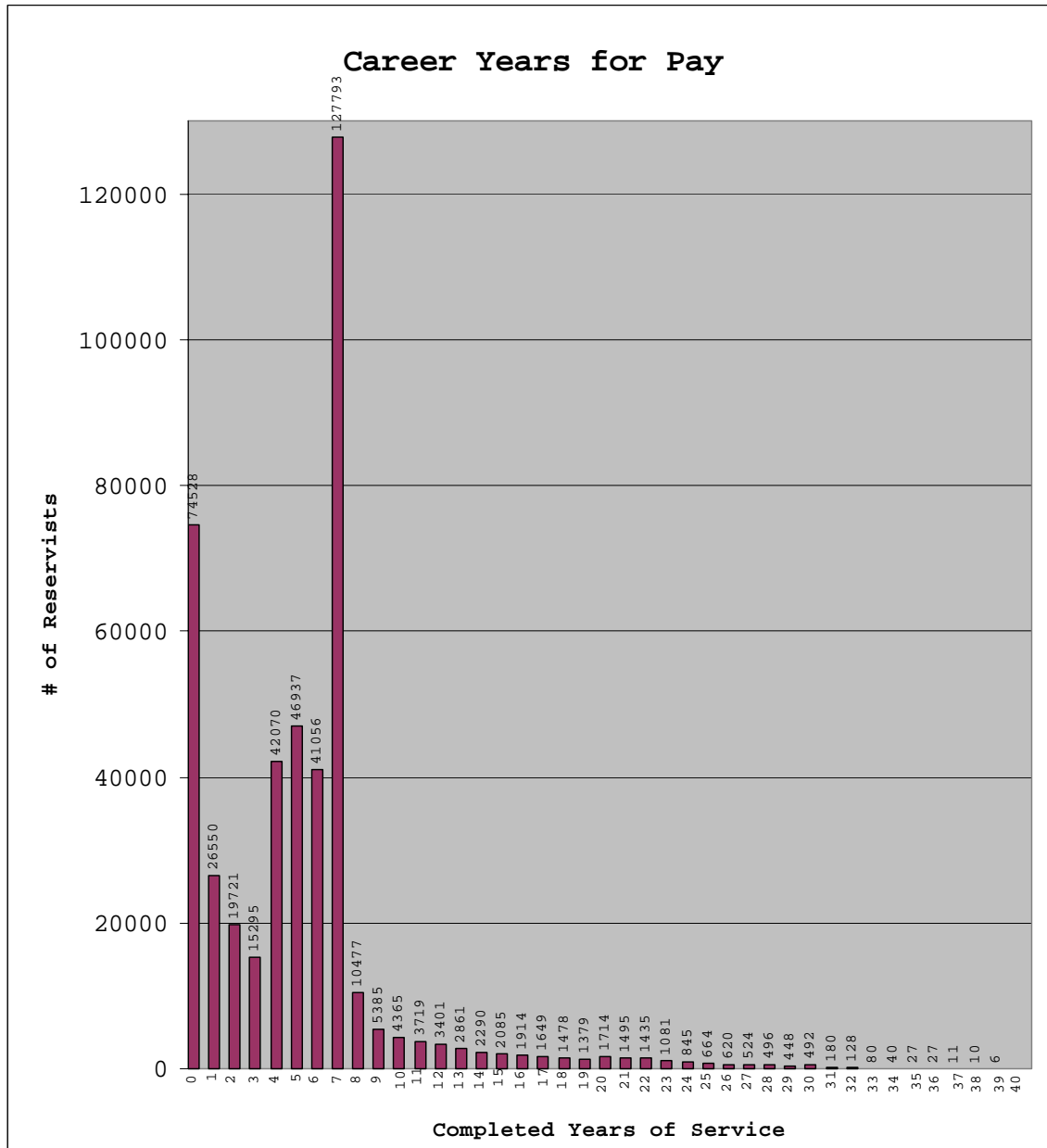
This is done because the information in this field does not change over the length of an individual's service, and the first occurrence is easily definable in SAS programming language.

e. Last Occurrence of a Variable

Information from the last occurrence (prior to retirement if applicable) of a record is used in the following fields: Pay Years, Dependents, Length of Time Mobilized, Number of Mobilizations, and Home of Record State Unemployment Rate at the End of Service. The data at this point in these variables is determined to be the most pertinent to the individual's decision to stay or leave the service. While there typically are changes throughout a career (number of dependents, Years of Service, Unemployment Rate) the ending value is understood as the most critical to the decision making process.

Figure 7 shows the length of service distribution found in the reserve population. It is understood that

certain length of service limitations and other force-shaping tools are employed in the creation of the reserve force structure. These tools notwithstanding, there is an interesting trend shown from Year 9 through Year 20. The

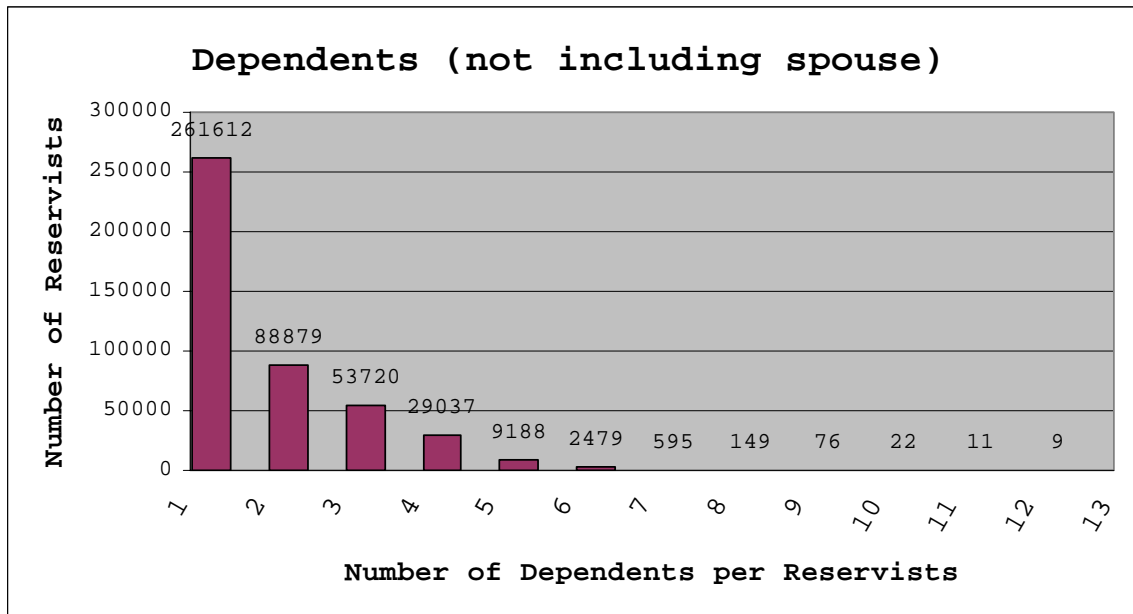


(Source: Author)

Figure 7. Distribution of Years of Reserve Service
number of persons remaining in the reserves becomes significantly more level than in Years 1-8. Year 7 is

clearly seen as the end of an individuals' commitment by contractual obligation to remain in the service.

Figure 8 displays the distribution of dependents per service member (not including spouse). This is obviously a different from what would be displayed if the data were taken from the first data point of a record.



(Source: Author)

Figure 8. Distribution of Dependents of Service Members

f. Time Activated

To calculate the time that each individual is activated, `Active_duty_begin_date` is subtracted from `Active_duty_end_date`. Periods of reserve activation often last longer than originally estimated and so the corresponding Active duty end date is not necessarily correct. To determine the length of periods of activation, the Active duty end date with the most recent file date of each separate Active duty begin date is the data used for the calculation of the variable "Totaldays". There were eight records that reflected a negative value for their

activation period length. These records were eliminated from the analysis because of the inaccuracy reflected in the data entry.

g. Number of Activations

The number of separate activation periods is summed and creates a new variable, "N-Callup." This variable is designed to analyze the number of times an individual is activated and is compared to the individual's total length of activation. For those individuals who span the data set gap (1992-1996) vital information is absent and unable to be estimated or recreated.

Times Called to Active Duty				
# of Activations	Frequency	Cumulative Percent	Cumulative Frequency	Percent
1	73933	68.14	73933	68.14
2	25440	23.45	99373	91.58
3	6317	5.82	105690	97.41
4	1718	1.58	107408	98.99
5	584	0.54	107992	99.53
6	265	0.24	108257	99.77
7	116	0.11	108373	99.88
8	48	0.04	108421	99.92
9	32	0.03	108453	99.95
10	25	0.02	108478	99.98
11	13	0.01	108491	99.99
12	5	0.00	108496	99.99
13	3	0.00	108499	100.00
14	2	0.00	108501	100.00
17	2	0.00	108503	100.00
19	1	0.00	108504	100.00

(Source: Author)

Figure 9. Number of Times Called to Active Duty

This is a similar problem to the Reserve Category Group variable and is handled in the same manner. The number and frequency of calls to active duty is presented in Figure 9. Persons with no activations are included in the analysis, but not reflected in the figure above in order to present the dramatic drop in numbers of persons activated more than two times. This suggests that successive activations has an adverse effect on retention in the reserve component and is accounted for when assignments for activation are made

by planners responsible for the utilization of reserve forces.

h. Unemployment Rate by State Home of Record at the End of Service

As the name of the variable implies, each individual has had his Home of Record State unemployment rate computed, as of the time of his end of service. This required the cross-tabulation of the Bureau of Labor and Statistics data with each Home of Record State at the time of the individual Marines' end of service. The Home of Record State information was taken from the individuals' last reserve file prior to his end of service. This variable assumes that the individual Marine either returns to his original Home of Record, or that he has updated his Home of Record to reflect the state he currently resides in at his election to end his service in the reserves. In the reserve forces the second assumption is less likely than in the active component Marine Corps, because individuals in the reserves typically serve in units within their own home state.

F. CHAPTER SUMMARY

This chapter has presented the sources of the data used, introduced the theoretical framework of the model with its basis in the literature review and the use of logistic regression as the means of analysis, specified the models used in the analysis, and described the variables (dependent and independent) that create the basis for this analysis. The results of the model are presented in Chapter IV.

IV. DATA ANALYSIS

This chapter presents the results of the logistic regression analysis performed on the data. Along with the results are provided the interpretation and findings of the analysis.

A. REGRESSION RESULTS

Model 1 is found to be a valid explanatory model of the individual decision to 'stay or leave' service in the Marine Corps Reserves.

1. Goodness of Fit

The global null hypotheses test shows that Model 1, at the .01 level, explains the individual decision to stay or leave the reserves much better than the model with just the intercept (as shown in Figure 10). This test uses -2 times the Log-Likelihood to measure the validity of Model 1.

Model Fit Statistics			
<u>Cri t e r i o n</u>	<u>I n t e r c e p t O n l y</u>	<u>I n t e r c e p t a n d C o v a r i a t e s</u>	
-2 L o g L	470550.00	357917.61	
Testing Global Null Hypothesis: BETA=0			
<u>T e s t</u>	<u>C h i - S q u a r e</u>	<u>D F</u>	<u>P r > C h i S q</u>
L i k e l i h o o d R a t i o	112632.389	10	<.0001

(Source: Author)

Figure 10. Model Fit Statistics

2. Accuracy of Model 1

The analysis compares the predicted values of the model with the observed responses in the population. Figure 11 displays the results of that comparison. The results indicate a strong ability (81% of predictions), by Model 1 to explain the population decision to stay in or leave the reserves.

Association of Predicted Probabilities and Observed Responses	
Percent Concordant	81.0
Percent Discordant	18.8
Percent Tied	0.2
Pairs	33764704906

(Source: Author)

Figure 11. Predicted Probabilities and Observed Responses

Model 1 has an R-Square of 0.227 (the percentage of variation explained by the Model), and a re-scaled R-Square of 0.3445 (the Models adjusted R^2 based on the number of explanatory variables, given the sample size). This Model explains one-third of the variation between an individuals' decision to continue in the service, as described by the explanatory variables.

3. Effects of Individual Independent Variables

Figure 12 displays the values of the individual independent variables and the effect that each has on the predicted logit. As presented in the definition of the base case, a white male with no dependents, no years of service and no mobilization or call to service is the base for computing the likelihood of an individual to stay in the reserves.

Analysis of Effects and Maximum Likelihood Estimates				
<u>Variable</u>	<u>DF</u>	<u>Estimate</u>	<u>Std. Error</u>	<u>Pr > ChiSq</u>
Intercept	1	4.1057	0.03500	<.0001
sex (Female)	1	0.1568	0.00933	<.0001
Dependents	1	0.0285	0.00309	<.0001
urate	1	-1.1437	0.00686	<.0001
PAY_YRS	1	0.00989	0.00147	<.0001
ncallup	1	0.9763	0.00826	<.0001
total days	1	-0.00005	8.30E-6	<.0001
rcga	1	0.0037	0.00027	<.0001
rcgb	1	-0.00481	0.00034	<.0001
rcgc	1	0.0442	0.00165	<.0001
rcgd	1	-0.5051	0.03030	<.0001

(Source: Author)

Figure 12. Logistic Regression Results

The 95% Wald confidence limits of exponentiated effects of the individual independent variables are shown in Figure 13.

<u>Odds Ratio Estimates</u>				
Effect		Point Estimate	95% Wald Confidence Limits	
sex	F vs M	1.368	1.319	1.419
Dependents		1.029	1.023	1.035
urate		0.319	0.314	0.323
PAY_YRS		1.010	1.007	1.013
ncallup		2.655	2.612	2.698
total days		1.000	1.000	1.000
rcga		1.004	1.003	1.004
rcgb		0.995	0.995	0.996
rcgc		1.045	1.042	1.049
rcgd		0.603	0.569	0.640

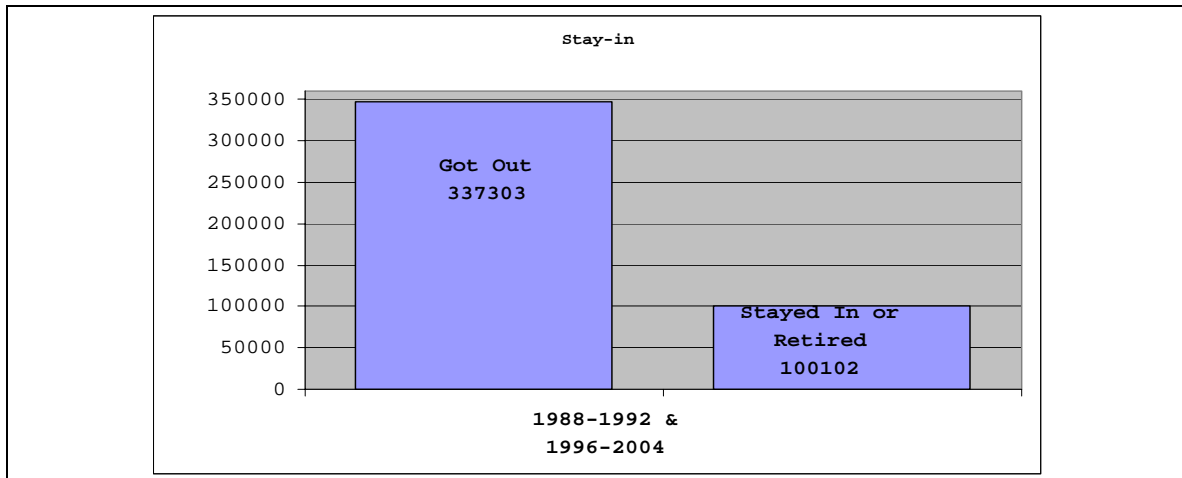
(Source: Author)

Figure 13. Confidence Intervals of Independent Variables

4. Decisions of Individuals in the Population

Of the 437,405 observations in the data set, 10,322 observations were deleted because they had missing values for the response or explanatory variables. It is assumed that the deletion of these observations does not detract significantly from the remaining data. Of those individuals remaining in the data set, the individuals that stay in make up just under one-quarter of the individuals (Figure 14).

<u>Population Response Profile</u>	
<u>STAY-IN</u>	<u>Frequency</u>
1	100102
0	337303



(Source: Author)

Figure 14. Distribution of Marines that Stay-in and Leave

B. INTERPRETATION OF RESULTS

1. Influence of Variables

Each of the variables in Model 1 are found to be significant at the .01 level. The variables sex (if Female), dependents, PAY_YRS (years of service), ncallup (times called to active service), rcga (Selected Reserve), and rcgc(Standby Reserve (Active and Inactive)), have a positive effect on the predicted logit. The variables urate (State Home of Record Unemployment Rate), totaldays (Sum of total days served on active duty while serving in the reserves), rcgb (Months served in Individual Ready Reserve[IRR]), and rcgd (Months served in Retired Reserve) have negative effects on the predicted logit as they increase.

Analysis of Maximum Likelihood Estimates				
Parameter	DF	Estimate	Std. Error	Pr > ChiSq
Intercept	1	4.1057	0.0350	<.0001
Sex = Female	1	0.1568	0.00933	<.0001
Dependents	1	0.0285	0.00309	<.0001
Urate	1	-1.1437	0.00686	<.0001
PAY_YRS	1	0.00989	0.00147	<.0001
Ncal1up	1	0.9763	0.00826	<.0001
Total days	1	-0.00005	8.302E-6	<.0001
RCGA	1	0.00372	0.000274	<.0001
RCGB	1	-0.00481	0.000338	<.0001
RCGC	1	0.0442	0.00165	<.0001
RCGD	1	-0.5051	0.0303	<.0001

(Source: Author)

Figure 15. Variable Values from Maximum Likelihood Estimate

2. Base Case

The base case individual, a single male with no dependents, mobilizations, and zero years of service, is defined by the intercept value of 4.1057 in Figure 15. If an individual is female, 0.1568 is added to the intercept, increasing the likelihood the individual will stay in the reserves. Similarly, for every day an individual serves on active duty 0.00005 is subtracted from the predicted logit value. The estimated standard error values of each variable are generally small. Thus, the estimated values of the variables should be fairly reliable for use in predicting individual behavior based on the known values of an individual record.

3. Partial Effects

An example for the calculation of an individual's likelihood to stay in the reserves is shown in Figure 16.

	Intercept	Sex	# Dependents	Unemploy Rate	# Pay Years	# Activations	Total Days Activated	RCGA	RCGB	RCGC	RCGD	Log Odds of Staying In
Base-Case Estimate	4.1057	Male	0.0285	-1.1437	0.00989	0.9763	-0.00005	0.00372	-0.0048	0.0442	-0.5051	4.51466
Individual A		Male	3	6.2%	14	3	340	165	0	0	0	

Value	4.1057	0	0.0855	-7.09094	0.13846	2.9289	1.2648	0.6138	0	0	0	2.04622
Individual B		Female	1	4.7%	6	1	180	6	0	60	0	
Value	4.1057	0.1568	0.0285	-5.37539	0.05934	0.9763	-0.009	0.02232	0	2.652	0	2.61657

(Source: Author)

Figure 16. Partial Effects

C. FINDINGS

All variables used in Model 1 are statistically significant, but only Sex, Unemployment Rate, Months spent in the Reserves (RCGD), and number of activations have practically significant influence on an individual decision to stay or go. With the inability to influence the first two variables, the number of calls to active duty and the amount of time spent by individuals from retirement (prior to a recall) are the only controllable variables by the Marine Corps Reserve as it attempts to influence retention.

There are several limitations to the findings of this analysis. First is the model's inability to identify more than 33% of the factors that comprise the population's decision to stay in the reserves. Second is the limitations imposed by the availability of data. There are several variables that have previously been shown to have an impact on retention behavior that were not able to be included in the model as a result of data manipulation limitations. Particularly, the variables for rank, ethnicity, marital status, and education level were all found to be unusable. Rank was not found to be of significance because of the dominance of the values of Sergeants and Captains/Majors (in the enlisted and officer ranks respectively). The analysis continually produced questionable validity in the fit of the model with the

inclusion of this variable. Ethnicity was too heavily influenced by three-quarters of the observations having missing values. Marital status was highly correlated to the number of dependents, and various weightings of these were unable to improve the power of the model. Educational level did not have enough variation in the population to be of significance in the analysis and so was left out.

Additionally, the variables that were included only serve as proxies for the individual's propensity to stay in, not the actual propensity.

The models for the various occupational fields and the propensity to 'stay in' described in Model 2 were not able to produce significant results. The effects shown across the preponderance of the occupational fields did not show significant variance to be of interest, and those fields that did have significantly different effects on retention did not have a sufficient number of data points to perform a valid analysis. Thus, Model 2 was left out of this report.

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V. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This was an empirical study in which a logistic regression model was formulated to assess the impact of mobilization and unemployment on the individual's decision to stay-in or leave the reserves. The goal was to find out the attrition behavior of U.S. Marine Corps Reserve participants in order to better establish recruiting and retention goals in the Marine Corps Reserve population. Questions regarding attrition influencers, effects of mobilization, and applicability to both officer and enlisted personnel were reviewed in this process.

Currently, at Headquarters Marine Corps (Reserve Affairs), attrition is studied as it relates to the Global War on Terrorism (GWOT). Manpower Analysts continue to study how the GWOT is affecting the retention. While numerous factors impact a Marine's desire to continue to serve, finding out if attrition can be predicted based on mobilization rates and unemployment rates was the focus of this analysis.

B. RECOMMENDATIONS FOR AREAS OF FUTURE STUDY

An attempt was made to perform a quantitative analysis of current and historical Marine Corps Reserve Attrition by rank, by unit, by Major Command, by Military Occupational Specialty, by Gender, by Obligor/Non-Obligor by Mobilized/Non Mobilized Units. This breakdown, while potentially useful to force planners and recruiting goals was found to be beyond the scope of this study. Sadly,

targeted retention and recruiting goals cannot be established with the limited findings of this study.

C. CONCLUSIONS

The effects of being called to active service are shown to have a positive effect on retention in the Marine Reserves. Similarly, serving in the Stand-by Reserves and the Ready Reserves are both shown in the model to have a positive effect on reserve retention. This makes sense, in that when an individual volunteers in the Marine Reserves, he or she has a desire to serve his country when called to do so. The negative effect of an increase in the number of days served on active duty, as shown in the results of the model, follows similar logic. Had the individual wanted to serve on a full-time active duty basis he would have volunteered for the active duty component. The longer he is asked to remain on active duty, the more dissatisfied he is, on average, with his participation in the reserves.

The negative effect of an increase in the individual's home of record unemployment rate is also consistent with previous findings, and when combined with the negative effect of continued mobilization and recall from the IRR or retired status are seen to have a significant impact on the individual reservist's decision to stay or leave. Because of the strong positive influence of the number of calls to active duty, the positive effect of being activated outweighs the negative effect of days of activation. The findings indicate that multiple short activations have less of a negative impact than a smaller number of lengthy activations.

By developing a logistic regression model, this study did validate previous research regarding the likelihood to continue to serve in the Marine Corps Reserve. As a result, the Marine Corps has the potential to better allocate resources and schedule individual activations, reducing attrition. This can assist in developing the proper force structure when the services of the Marine Corps are needed by the President of the United States or by Congress, insofar as it's Congress' prerogative to declare war.

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APPENDIX 1. DMDC 1988-1992 DATA

(in order of field's supplied by DMDC)

Social Security Number
Primary Occupation Code
Duty Occupation Code
Education Level
Unit Identification State Code
Pay Grade
Home of Record
Date of Birth
Race
Source of Commission/Enlisted Source of Enlistment
Years for Retirement
Marital Status
Dependents
Age
Ethnic Group
Race and Ethnic Group
Sex
Education Tier
Officer Basic Branch/Enlisted Career Master File
Command Status/ Enlisted Armed Forces Qualification Test Category
Officer Military Education/Enlisted Armed Forces Qualification Test Percentile
Primary Military Occupational Specialty
Separation Program Designator
Inter-service Separation Code
Reserve Group
Date of Rank
Date of Commission/Warrant/Enlistment
Reserve Category
Education Incentive Type
Pay Entry Base Date
Assignment Unit Identification Code
Duty Military Occupational Specialty
Years of Service for Pay
Selected Reserve Obligation
Secondary Occupation Code
Zip Code Unit Identification Code
Zip Code Home of Record
Spouse Social Security Number
Social Security Number Verification
Military Service Obligation Expiration Date
Active Duty Start Date
Active Duty Stop Date
Security Clearance
Retirement Points
Retirement Points Paid
Retirement Points Career
Date of Transfer to Standby/Retired
Congressional District Unit Identification Code
Characterization of Service
Reenlistment Eligibility
File Date
Program Element Code
Selected Reserve Transition Data
Prior Service Indicator
Secondary Military Occupational Specialty
Selected Reserve Estimated Time on Station

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APPENDIX 2. DMDC 1996 - 2004 DATA

(in order of field's supplied by DMDC)

SVC	RES_CAT
RES_SUBCAT	RES_CATGROUP
SSN	BIRTH_DT
SEX	MARITAL
RACE	ETHNIC
RACE_ETHIC	CITIZEN
CITIZEN_ORG	EDUC
EDUC_TIER	STATE_POST
ZIP	STATE_NUM
STATE_CONGRESS	DEPENDENTS
SPOUSE_SSI	SPOUSE_SVC
SPOUSE_USO	UNI_ENTRY_DT
RES_ENTRY_DT	PAY_YRS
ACCESSIONS	OFFICER_DT
REG_SVC	RES_SVC
RES_SVC_OB_L	ACT_BEG_DT
ACT_END_DT	RES_PROJ_END_DT
RES_BEG_DT	RES_END_DT
GRADE	GRADE_MOS
MIL_END_DT	AERO_RATING
FLY_STATUS	PRIMARY_OCC
DUTY_OCC	SEC_OCC
MIL_EDUC	JOINT_MIL_EDUC
COMMAND	AFQT_PERC
AFQT_CAT	STAND_BEG_DT
OFFICER_END_DT	UIC
UNIT_ZIP	UNIT_STATE
UNIT_MJ_COMMAND	DUTY_UIC
ACCESS_SEC	FILE_DT
MASTER_RES	SEP_PROGRAM
INTER_SEP	MIL_SER_CHAR
REENLIST	SEL_RES_LOSS
MEP_MARITAL	MEP_PRIOR_SVC
MEP_ENLISTED	RSV_SVC_BONUS
ACT_SVC_LOSS	RSV_ACT_LOSS
RES_RET_EARN	RES_RET_PAID
RES_RET_CAREER	RES_RET_ELIG
MOB_CAT	

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APPENDIX 3. DEFINITIONS OF VARIABLE-TYPE

E = person has records from first data period (1988-1992)
L = person has records from later data period (1996-2004)
1 = person has a record from the first month of a period
2 = person has a record from the last month of a period

Example:

L = person has records in the later period only. Since the first or last months are not included, we know when the person both entered and left the reserves within this period.

E12L1 = person has a record from every month covered in the early period and records continue into the later period.

Type	Appear
1	L
2	L2
3	L1
4	L12
5	E
6	E2
7	E2L1
8	E2L12
9	E1
10	E12
11	E12L1
12	E12L12
13	EL
14	EL2
15	EL1
16	EL12
17	E2L
18	E2L2
19	E1L
20	E1L2
21	E1L1
22	E1L12
23	E12L
24	E12L2

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